

## PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION  
(PCT Rule 61.2)

Date of mailing (day/month/year) 15 May 2001 (15.05.01)	To:  Commissioner US Department of Commerce United States Patent and Trademark Office, PCT 2011 South Clark Place Room CP2/5C24 Arlington, VA 22202 ETATS-UNIS D'AMERIQUE  in its capacity as elected Office
International application No. PCT/SE00/01623	Applicant's or agent's file reference 111915 USN/KL
International filing date (day/month/year) 24 August 2000 (24.08.00)	Priority date (day/month/year) 24 August 1999 (24.08.99)
Applicant  KRUSE, Björn	

1. The designated Office is hereby notified of its election made:

 in the demand filed with the International Preliminary Examining Authority on:

05 March 2001 (05.03.01)

 in a notice effecting later election filed with the International Bureau on:

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2. The election  was was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland  Facsimile No.: (41-22) 740.14.35	Authorized officer  Claudio Borton  Telephone No.: (41-22) 338.83.38
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## PATENT COOPERATION TREATY

2000-11-01

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING  
SUBMISSION OR TRANSMITTAL  
OF PRIORITY DOCUMENT

(PCT Administrative Instructions, Section 411)

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Date of mailing (day/month/year) 23 October 2000 (23.10.00)	To:
Applicant's or agent's file reference 111915 USN	<b>IMPORTANT NOTIFICATION</b>
International application No. PCT/SE00/01623	International filing date (day/month/year) 24 August 2000 (24.08.00)
International publication date (day/month/year) Not yet published	Priority date (day/month/year) 24 August 1999 (24.08.99)
Applicant FINGERPRINT CARDS AB et al	

1. The applicant is hereby notified of the date of receipt (except where the letters "NR" appear in the right-hand column) by the International Bureau of the priority document(s) relating to the earlier application(s) indicated below. Unless otherwise indicated by an asterisk appearing next to a date of receipt, or by the letters "NR", in the right-hand column, the priority document concerned was submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b).
2. This updates and replaces any previously issued notification concerning submission or transmittal of priority documents.
3. An asterisk(\*) appearing next to a date of receipt, in the right-hand column, denotes a priority document submitted or transmitted to the International Bureau but not in compliance with Rule 17.1(a) or (b). In such a case, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.
4. The letters "NR" appearing in the right-hand column denote a priority document which was not received by the International Bureau or which the applicant did not request the receiving Office to prepare and transmit to the International Bureau, as provided by Rule 17.1(a) or (b), respectively. In such a case, the attention of the applicant is directed to Rule 17.1(c) which provides that no designated Office may disregard the priority claim concerned before giving the applicant an opportunity, upon entry into the national phase, to furnish the priority document within a time limit which is reasonable under the circumstances.

<u>Priority date</u>	<u>Priority application No.</u>	<u>Country or regional Office or PCT receiving Office</u>	<u>Date of receipt of priority document</u>
24 Augu 1999 (24.08.99)	9902990-2	SE	25 Sept 2000 (25.09.00)

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland  Facsimile No. (41-22) 740.14.35	Authorized officer  L. Nicolo   Telephone No. (41-22) 338.83.38
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**PATENT COOPERATION TREATY**  
**PCT**  
**INTERNATIONAL PRELIMINARY EXAMINATION REPORT**

REC'D 19 DEC 2001

PCT

(PCT Article 36 and Rule 70)

12

Applicant's or agent's file reference <b>111915 USN/KL</b>	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. <b>PCT/SE00/01623</b>	International filing date (day/month/year) <b>24.08.2000</b>	Priority date (day/month/year) <b>24.08.1999</b>
International Patent Classification (IPC) or national classification and IPC7 <b>G 06 K 9/50, G 06 K 9/80, A 61 B 5/117</b>		
Applicant <b>Fingerprint Cards AB et al.</b>		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of \_\_\_\_\_ sheets.

3. This report contains indications relating to the following items:

- I  Basis of the report
- II  Priority
- III  Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV  Lack of unity of invention
- V  Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI  Certain documents cited
- VII  Certain defects in the international application
- VIII  Certain observations on the international application

Date of submission of the demand <b>05.03.2001</b>	Date of completion of this report <b>11.12.2001</b>
Name and mailing address of the IPEA/SE <b>Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88</b>	Authorized officer <b>Patrik Blidefalk/AE Telephone No. 08-782 25 00</b>

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/SE00/01623

## I. Basis of the report

## 1. With regard to the elements of the international application:\*

 the international application as originally filed the description:

pages \_\_\_\_\_, as originally filed

pages \_\_\_\_\_, filed with the demand

pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

 the claims:

pages \_\_\_\_\_, as originally filed

pages \_\_\_\_\_, as amended (together with any statement) under article 19

pages \_\_\_\_\_, filed with the demand

pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

 the drawings:

pages \_\_\_\_\_, as originally filed

pages \_\_\_\_\_, filed with the demand

pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

 the sequence listing part of the description:

pages \_\_\_\_\_, as originally filed

pages \_\_\_\_\_, filed with the demand

pages \_\_\_\_\_, filed with the letter of \_\_\_\_\_

## 2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language \_\_\_\_\_ which is:

 the language of a translation furnished for the purposes of international search (under Rule 23.1(b)). the language of publication of the international application (under Rule 48.3(b)). the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

## 3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

 contained in the international application in written form. filed together with the international application in computer readable form. furnished subsequently to this Authority in written form. furnished subsequently to this Authority in computer readable form. The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished. The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.4.  The amendments have resulted in the cancellation of: the description, pages \_\_\_\_\_ the claims, Nos. \_\_\_\_\_ the drawings, sheet/fig \_\_\_\_\_5.  This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).\*\*

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**1. Statement**

Novelty (N)	Claims	<u>1-12</u>	YES
	Claims	_____	NO
Inventive step (IS)	Claims	<u>1-12</u>	YES
	Claims	_____	NO
Industrial applicability (IA)	Claims	<u>1-12</u>	YES
	Claims	_____	NO

**2. Citations and explanations (Rule 70.7)**

**Prior art**

Prior art, cited in the search report, consists of the following documents:

- (D1) GB 2 310 522, A
- (D2) US 5 140 642, A
- (D3) US 5 239 590, A
- (D4) Precise Biometrics, Linus Wiebe et al.; "Automated recognition of fingerprints"; See page 33, abstract, published 1998-04-03

D1, D2, D3 and D4 describes different methods and arrangements for registering and verifying of fingerprints, e.g. by finding and registering allocated core points or classifying parts of the fingerprint. However, the methods and arrangements in D1-D4 are more complicated and do not describe the claimed invention. Therefore, D1-D4 merely defines state of the art.

**Statement of reasons**

None of documents D1-D4, nor any combination of them, describe such a method, as claimed in claims 1-6, or such an arrangement, as claimed in claim 7-12. There is also no teaching in the cited art leading a skilled person to this method or this arrangement. Therefore, the claimed invention is novel and involves an inventive step.

Accordingly, claims 1-12 are novel (N) and fulfil the requirements of inventive step (IS) and industrial applicability (IA).

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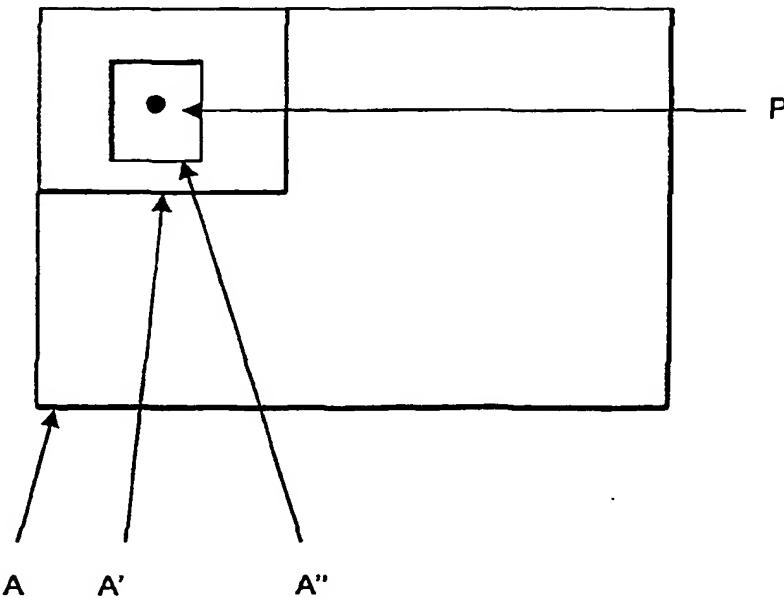
(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

— With international search report.

[Continued on next page]

(54) Title: METHOD AND ARRANGEMENT FOR REGISTERING AND VERIFYING FINGERPRINT INFORMATION



(57) Abstract: The invention relates to a method and an arrangement for registering fingerprint information via a sensing surface (A). The method comprises scanning part surfaces (A') in the sensing surface (A), checking whether the centre point (P<sub>1</sub>), with its immediate surrounding area (A''<sub>1</sub>), of each scanned part surface (A') is unique within the part surface (A') and registering a first number of centre points (P<sub>1</sub>) which, with their respective immediate surrounding areas (A''<sub>1</sub>), are unique within their respective part surfaces (A'). The respective immediate surrounding areas (A''<sub>1</sub>) of the points and the respective part surfaces (A') of the points are also registered. The invention also relates to a method and an arrangement for verifying fingerprint information, in which verification is carried out on the basis of registered information relating to a fingerprint which is to be approved

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in the verification method. The method comprises a number of part surface (A') with their respective centre points (P<sub>1</sub>) in the fingerprint whose information is registered being compared with corresponding part surfaces (A'') on the sensing surface (A). If there is a point (P<sub>2</sub>) on a part surface (A'') on the sensing surface A which, with its immediate surrounding area (A''<sub>2</sub>), corresponds to the registered centre point (P<sub>1</sub>) including its immediate surrounding area (A''<sub>1</sub>) in the corresponding stored part surface (A'), the point (P<sub>2</sub>) with its part surface (A'') is approved. If a certain number of points (P<sub>2</sub>) with associated part surfaces (A'') have been approved, these are selected for a first step in further processing.

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*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

**TITLE**

Method and arrangement for registering and verifying fingerprint information

**TECHNICAL FIELD**

5 The present application relates to a method and an arrangement for registering and verifying fingerprint information.

**BACKGROUND ART**

10 There are a great many fields within which it is necessary to verify the identity of a person, in other words to answer the question of whether a certain person is who he claims to be and is thus authorized to use a certain type of equipment. Examples of such equipment are automatic cash dispensers, access systems and various types of electronic equipment, for example mobile telephones and computers.

15 A conventional manner of carrying out verification is for the user to have a code or a password which he has to input in a verification procedure. If the code is correct, the user is considered to be authorized to use the equipment. However, it can be difficult for a user to remember a large number of different  
20 codes and passwords, for which reason alternative ways of verifying the authority and/or identity of a user are necessary. One such alternative method is to have a user register information relating to one or more of his fingerprints in a verification unit, the user then, in a verification procedure, placing the finger or fingers whose print is registered against a surface on the  
25 verification unit. The unit analyses whether the fingerprint corresponds to the necessary degree to the fingerprint whose information is stored and, if so, the fingerprint is considered verified, and the user is permitted to use the equipment in question.

30 Identification by means of fingerprints has traditionally been used mostly within the field of crime prevention, where the question to be answered is not whether a fingerprint corresponds to another to the necessary degree. In that field, an attempt is instead made to establish a match with a specific  
35 fingerprint in an extensive register of fingerprints. This type of use of fingerprints does not involve the same great requirement for speed as a

verification procedure of the type described above. Speed is also highly desirable in the registering of fingerprint information for use in verification.

Another important parameter, for both registering and verification of 5 fingerprint information, is reliability.

#### DISCLOSURE OF INVENTION

The problem solved by the present invention is therefore that of providing an arrangement and a method affording rapid and reliable registering of 10 fingerprint information, and of providing a corresponding arrangement and method for rapid and reliable verification of a fingerprint on the basis of previously registered fingerprint information.

This problem is solved by means of a method for registering fingerprint 15 information via a sensing surface A, in which a finger can be held against or over at least a part of the sensing surface A, which method comprises scanning part surfaces in the sensing surface A. During scanning of the part surfaces, it is checked whether the centre point, with its immediate surrounding area, of each scanned part surface is unique within the part 20 surface.

A number of centre points which, with their respective immediate surrounding areas, are unique in their respective part surfaces are registered, the respective immediate surrounding areas of the points and the respective part 25 surfaces of the points also being registered.

A certain number of the registered centre points with their immediate surrounding areas are suitably selected for further use, for example for verifying fingerprints.

30 The abovementioned problem is also solved by means of a method for verifying fingerprint information via a sensing surface A, against or over at least a part of which sensing surface A a finger can be held, in which verification is carried out on the basis of previously registered information 35 relating to at least one fingerprint which is to be approved in the verification

method, and in which information has preferably been registered according to the registering method described above.

- 5 The verification method according to the invention comprises a number of part surfaces with their respective centre points in the fingerprint whose information is stored being compared with corresponding part surfaces on the sensing surface A. If there is a point on a part surface on the sensing surface A which, with its immediate surrounding area, corresponds, on the basis of certain criteria, to the stored centre point, including the immediate 10 surrounding area of the stored centre point in the corresponding stored part surface, the point with its part surface is approved. If a certain number of points with associated part surfaces have been approved, these are selected for a first step in further processing.
- 15 This first step in further processing suitably comprises a number of the selected points and the part surfaces being analysed as a group, the mean value of the coordinates for the points in their respective part surfaces being calculated. The mean value calculated is seen as a point in each part surface, and a certain number of the points with their associated part 20 surfaces are selected for a second step in further processing, the points which are selected being those points in the group which have the smallest distance to the mean value point in their respective part surface. This is done in order that an arrangement or a method according to the invention will be independent of translation of the print at the time of verification in relation to 25 the position of the finger at the time of registering, translation being defined as right-angled displacements of the finger relative to the position of the finger at the time of registering.
- 30 The invention also comprises a method for making it possible to be independent of rotation of the finger at the time of verification in relation to the position of the finger at the time of registering. This method will be described in greater detail below.
- 35 The invention also comprises arrangements for use in the methods of the types mentioned above.

### BRIEF DESCRIPTION OF DRAWINGS

The invention will be described in greater detail below with reference to the appended drawings, in which

5 Fig. 1 shows a rough block diagram of an arrangement according to the invention,

Fig. 2 shows a basic diagram of the use according to the invention of a part surface on a sensor,

Fig. 3 shows the principle of a calculation according to the invention, and

10 Fig. 4 shows how a verification method according to the invention can be made insensitive to rotation.

### MODE(S) FOR CARRYING OUT THE INVENTION

Fig. 1 shows a rough block diagram of an arrangement 100 according to the invention. The arrangement 100 comprises a central unit 110, a sensor 120,

15 a power supply unit 130, and connections, shown by arrows, between the units. The central unit 110 suitably comprises control arrangements, a memory and at least one arithmetic logic unit (ALU). The control arrangements and the ALU together preferably consist of an integrated circuit, for example a microprocessor.

20

The power supply unit 130 is not of major interest in terms of the invention and will therefore not be described in greater detail. In brief, it can be stated that the power supply can be effected in a great many ways known to the expert, for example batteries, mains connection or solar cells, and can be 25 integrated in the same housing as the rest of the arrangement 100 or separate.

The sensor 120 has a sensing surface A, against or over at least a part of which sensing surface A a finger can be held during use of the arrangement.

30 The sensor 120 comprises a number of sensor elements for scanning the sensing surface A. The sensor elements are preferably capacitive, but other types of sensor element can also be used according to the invention, for example resistive, optical or heat-sensitive elements. Another type of sensor which could be used in connection with the present invention is a pressure-sensitive sensor.

The number of sensor elements per unit area on the sensing surface A can be selected in a great many ways, depending on, for example, the type of sensor, and the desired speed, reliability and resolution. In a preferred embodiment of the invention, with capacitive sensor elements, roughly 200 sensor elements are used per  $\text{mm}^2$ , which corresponds to 144x144 points per  $\text{cm}^2$ , which on a length scale can be expressed as 14 elements per millimetre. This number is to be considered as only an example, however, and the number of sensor elements per unit area can be either larger or smaller in other embodiments of the invention. However, the number of sensor elements preferably lies within the range 10-50 elements per millimetre.

As mentioned above, the arrangement 100 is intended to be used for registering fingerprint information and for verifying fingerprint information on the basis of previously registered information relating to at least one fingerprint which is to be approved on verification. The previously registered information used for verifying fingerprints has preferably been registered by means of a method according to the invention.

Below, a method of registering fingerprint information according to the invention will be described first, and then a method for verifying fingerprint information according to the invention will be described. These methods are implemented by means of an arrangement according to the invention. Both the description of registering and the description of verification below will be given with reference to Fig. 2. None of the parts in Fig. 2 is provided with an index, but parts which have been provided with an index in the text refer to corresponding unindexed parts in Fig. 2.

In a method for registering fingerprint information according to the invention, the user places the finger whose information is to be registered against or over a part of the sensing surface A (shown in Fig. 2) on the sensor 120. The central unit 110 then initiates scanning of the sensing surface A of the sensor 120, which is carried out by part surfaces A'1 on the sensing surface A being scanned. The part surfaces A'1 preferably overlap one another in a predetermined manner. The part surfaces A'1 are suitably all of the same size, which can of course be varied in a great many different ways. However,

a suitable range for the size of the part surfaces  $A'_1$  is 5-50% of the total sensor surface A, 10% of the total sensor surface having been found to be advantageous.

- 5 During scanning of the part surfaces  $A'_1$ , it is investigated, preferably in the central unit 110, whether the centre point  $P_1$  of the part surface, with its immediate surrounding area  $A''_1$ , is unique within the part surface  $A'_1$ . If so, the point  $P_1$  is approved and is registered together with its immediate surrounding area in the memory of the arrangement 100. The part surface  $A'_1$  10 to which the centre point belongs is also registered.

Scanning of the sensor surface A preferably continues until the central unit 110 has found a certain predetermined first number of centre points  $P_1$  which, including their immediate surrounding areas  $A''_1$ , are unique within 15 their part surfaces  $A'_1$ . When the predetermined first number of centre points  $P_1$  has been found and registered, registering of the finger is considered complete.

- 20 An alternative way of carrying out the scanning is to scan the part surfaces  $A'_1$  in a given pattern, data on the centre points  $P_1$  of all the part surfaces  $A'_1$  being gathered and stored. When all the part surfaces  $A'_1$  have been scanned, the central unit 110 selects a predetermined number of centre points  $P_1$  which best meet certain criteria with regard to the requirement that the centre point  $P_1$  is to be unique in its part surface  $A'_1$ .

- 25 A further alternative way of carrying out the scanning, which can save memory space, is to store the predetermined number of centre points  $P_1$  in a table which is updated throughout the scanning process with the centre points which best meet the abovementioned criteria.

- 30 All the first number of stored centre points  $P_1$  can of course be used for verifying a finger, but, in a particularly preferred embodiment of the invention, the central unit 110 selects a second number of the registered centre points  $P_1$  with their respective immediate surrounding areas  $A''_1$  for further use, the 35 centre points  $P_1$  which are selected being those which best meet certain predetermined criteria. The exact sizes of the first and the second number of

centre points are of course dimensioning parameters which are determined by the desired speed and reliability of the registering method, but it has been found to be advantageous if the first number lies within the range 10-100 points, and the second number lies within the range 20-80% of the first 5 number. In a particularly preferred embodiment, 24 and, respectively, 16 points are used.

A method for verifying fingerprint information according to the invention will be described below. The type of verification for which the invention is 10 primarily intended is to check whether the fingerprint of a finger which is held against or over the sensing surface A of the sensor corresponds to a fingerprint whose information was registered previously.

For verifying a fingerprint according to the invention, the user therefore 15 places a finger against or over a part of the sensing surface A on the sensor 120. The central unit 110 initiates scanning of the sensing surface A of the sensor 120, which is carried out by a number of part surfaces A'₂ on the sensing surface A being scanned. In terms of size and position on the sensing surface A, the scanned part surfaces A'₂ preferably correspond to 20 the part surfaces used in the registering method described above, which means that each part surface A'₁ in the fingerprint data which is registered corresponds to a part surface A'₂ for verification. The part surfaces A'₂ which are analysed first in the verification method are those which correspond to the part surfaces A'₁ whose respective centre points P₁ are registered.

25 If, when a part surface A'₂ is scanned, it emerges that a point P₂ in the part surface A'₂, with its immediate surrounding area A"₂, has, on the basis of certain criteria, sufficient similarity to the centre point P₁ and its immediate surrounding area A"₁ in the corresponding registered part surface A'₁, the 30 point P₂ is approved provisionally, and its coordinates in relation to the part surface A'₂ are stored in the memory of the arrangement 100. The coordinate system used is suitably an orthogonal x-y system in each part surface A'₂ with the origin in the centre of the part surface. If more than one point P₂ in a part surface A'₂ meets said criteria, the point P₂ which best meets the criteria 35 is selected.

If a certain number of points  $P_2$  have been approved and stored for the finger which is held against the sensing surface A, these points are selected for a first step in further processing.

- 5 In a possible verification method, the first step in the further processing quite simply comprises the fingerprint being considered verified, in other words the fingerprint which is held against or over the sensing surface A is considered to be identical with the fingerprint whose information is registered, if the number of approved points  $P_2$  exceeds a certain predetermined number. If greater reliability in verification is desired, however, the first step in the further processing can suitably also comprise the following, which is described with reference to Fig. 3.

The stored points  $P_2$  are analysed as a group, and the mean value of the coordinates  $(x_m, y_m)$  for all the points  $P_2$  is calculated, analysis and calculation suitably being carried out in the central unit 110. The calculation therefore provides a coordinate pair  $(x_m, y_m)$  which can be seen as a point in each part surface  $A'_2$ . The points  $P_2$  in the group are then arranged in a list, starting from the absolute value of the distance  $d$  between the coordinates  $(x_2, y_2)$  of a point and the calculated mean value point  $(x_m, y_m)$ . The distance  $d$  in a part surface  $A'_2$  is illustrated diagrammatically in Fig. 3.

A certain number of the points highest on the list are then selected for a second step in further processing. If appropriate, this second step can quite simply comprise the fingerprint being considered verified, in other words the fingerprint which is held against or over the sensing surface A is considered to be identical with the fingerprint whose information is stored, if a sufficient number of points have an absolute value  $d$  below a certain value. If greater reliability in verification is desired, however, the second step in the further processing can suitably comprise the following:

- 35 The mean value of the coordinates  $(x_2, y_2)$  of the selected points is calculated, and the absolute value of the distance between this mean value point and the coordinates  $(x_2, y_2)$  of each selected point is analysed. If a certain number of points  $P_2$  have a distance to the mean value point with an absolute value which is below a certain limit value, the fingerprint is considered verified, in

other words the fingerprint which is held against or over the sensing surface A is considered to be identical with the fingerprint whose information is registered.

- 5 The numbers of points required in the various steps of the verification method are of course, in the same way as with the numbers in the registering method, dimensioning parameters which are selected on the basis of the combination of speed and reliability desired in the arrangement. By way of example, however, it may be mentioned that the number of points selected
- 10 for a first step in further processing during verification can suitably correspond to the number of points selected in the final step of registering, in the present case, in other words, 16 points. The number of points selected for a second step in further processing in verification suitably lies within the range 20-60% of the number of points selected for the first step, preferably
- 15 50%, in the present case, therefore, 8 points.

The verification method described above means that good results are obtained even if, during a verification procedure, a user holds his finger displaced at right angles in the lateral or longitudinal direction in relation to the position the finger was in at the time of registering. As the user may also, at the time of verification, hold his finger in a rotated position in relation to the position the finger was in at the time of registering, the invention comprises means and a method to make it possible to carry out verification with good results even in such cases. This will be described below with reference to

20 Fig. 4.

In order that the verification will be insensitive to rotation of the finger, scanning and comparison are carried out according to the above description, in other words part surfaces A'₂ on the sensing surface are scanned. These

30 part surfaces A'₂ are compared with corresponding part surfaces A'₁ in the registered fingerprint with regard to centre points and the immediate surrounding areas of the centre points. In order to achieve rotation-insensitivity, however, each part surface A'₂ is displaced into a number of different angular positions  $\alpha$  around an imaginary vertical line L on the

35 sensing surface A before it is compared with the corresponding part surface A'₁. Comparison is then carried out with the part surfaces A'₂ in each of these

angular positions. If, in one and the same angular position, said number of points  $P_2$  have sufficient similarity, on the basis of the abovementioned criteria, to their corresponding registered part surfaces  $A'_1$ , these centre points  $P_2$  are selected for a first step in further processing, according to the 5 description above.

In the same way as described above, the scanning over the sensing surface A of the sensor 120 is controlled by the central unit 110 of the arrangement 100 in the rotation-insensitive case also. The different angular positions  $\alpha$  are 10 achieved by information about the finger which is held against the sensing surface A being stored in the memory 110 of the arrangement in the angular position in which the user holds the finger, after which rotation of the stored information takes place before comparison is carried out.

15 The number of angular positions into which the part surfaces  $A'_2$  are displaced can in principle be arbitrary, but the number of angular positions preferably lies within the range 10-100, and 16 angular positions can advantageously be used. The locations of the angular positions can in principle be selected freely, but, in a preferred embodiment, an odd number 20 of angles  $\alpha$  is selected around an imaginary centre line L on the sensing surface A, with one angular position which corresponds to  $\alpha=0$ , and an even number of angular positions of the same magnitude on each side of the centre line.

25 The invention is not limited to the embodiments described above but can be varied freely within the scope of the patent claims below.

## CLAIMS

1. Method for registering fingerprint information via a sensing surface A, against or over at least a part of which sensing surface A a finger can be held, characterized in that the method comprises:
  - scanning part surfaces A'1 in the sensing surface A,
  - checking whether the centre point P1, with its immediate surrounding area A"1, of each part surface A'1 scanned is unique within the part surface A'1,
  - a first number of centre points P1 which, with their respective immediate surrounding areas A"1, are unique in their respective part surfaces A'1, being registered, the respective immediate surrounding areas A"1 of the points and the respective part surfaces A'1 of the points also being registered.
- 15 2. Method according to claim 1, according to which a certain second number of the registered centre points P1, with their immediate surrounding areas A"1, are selected for further use.
- 20 3. Method for verifying fingerprint information via a sensing surface A, against or over at least a part of which sensing surface A a finger can be held, in which verification is carried out on the basis of previously registered information relating to at least one fingerprint which is to be approved in the verification method, which information has preferably been registered according to the method in claim 1, characterized in that the method comprises the following:
  - a number of part surfaces A'1 with their respective centre points P1 in the fingerprint whose information is registered are compared with corresponding part surfaces A'2 on the sensing surface A,
  - if there is a point P2 on a part surface A'2 on the sensing surface which, with its immediate surrounding area A"2, corresponds, on the basis of certain criteria, to the registered centre point P1, including the immediate surrounding area A"1 of the stored centre point in the corresponding stored part surface A'1, the point P2 with its part surface A'2 is approved,
- 25
- 30
- 35

- if a certain number of points  $P_2$  with associated part surfaces  $A'_2$  have been approved, these are selected for a first step in a further processing.

5 4. Method according to claim 3, also comprising information about the part surfaces  $A'_2$ , for comparison with the part surfaces  $A'_1$ , being displaced into a predetermined number of angular positions, comparison being carried out with the part surfaces  $A'_2$  in each of said angular positions, and, if said number of points  $P_2$  of part surfaces  $A'_2$  satisfy said conditions in 10 one and the same angular position, these points  $P_2$  being selected for the first step in the further processing.

15 5. Method for verifying fingerprints according to claim 3 or 4, according to which the first step in the further processing of the selected points  $P_2$  with their respective part surfaces  $A_2$  comprises a number of the selected points  $P_2$  and the part surfaces  $A_2$  being analysed as a group as follows:

- the mean value of the coordinates (x,y) for the points  $P_2$  in their respective part surfaces  $A_2$  is calculated,
- 20 - the mean value calculated is seen as a point in each part surface  $A_2$ ,
- a certain number of the points  $P_2$  with their associated part surfaces  $A_2$  are selected for a second step in a further processing, the points  $P_2$  which are selected being those points in the group which have the smallest distance to the mean value point in their respective part 25 surface  $A_2$ .

30 6. Method for verifying fingerprints according to claim 5, according to which the second step in the further processing of selected points  $P_2$  with respective part surfaces  $A_2$  comprises a number of the selected points  $P_2$  and the part surfaces  $A_2$  being analysed as a group as follows:

- the mean value of the coordinates (x,y) for the points  $P_2$  in the part surfaces  $A_2$  is calculated,
- the mean value calculated is seen as a point in each part surface  $A_2$ ,
- the distance between the points  $P_2$  in the group and the mean value 35 point is analysed,

- if the distance between a certain number of points  $P_2$  and the mean value point is below a certain limit value, the fingerprint is considered verified.

5 7. Arrangement (100) for use for registering fingerprint information, comprising a central unit (110), a sensor (120) with a sensing surface A, against or over at least a part of which sensing surface A a finger can be held, and a power supply unit (130), characterized in that it comprises:

- 10 - means (110, 130) for scanning part surfaces  $A'_1$  in the sensing surface A of the sensor (120),
- means (110, 130) for analysing whether the centre point  $P_1$ , with its immediate surrounding area  $A''_1$ , of a scanned part surface  $A'_1$  is unique within the part surface  $A'_1$ ,
- 15 - means (110, 130) for registering a first number of centre points  $P_1$  which, with their respective immediate surrounding areas  $A''_1$ , are unique in their respective part surfaces  $A'_1$ ,
- means (110, 130) for registering the part surfaces  $A'_1$  whose centre points  $P_1$  are registered.

20 8. Arrangement (100) according to claim 6, also comprising means (110) for selecting a certain second number of the registered part surfaces  $A'_1$  with associated centre points  $P_1$  and immediate surrounding areas  $A''_1$  for further use.

25 9. Arrangement (100) for use for verifying fingerprints on the basis of previously registered information relating to at least one fingerprint which is to be approved by means of the arrangement, which arrangement comprises a central unit (110), a sensor (120) with a sensing surface A, against or over 30 at least a part of which sensing surface A a finger can be held, and a power supply unit (130), characterized in that it comprises the following:

- means (110, 130) for comparing a number of part surfaces  $A'_1$  with respective centre points  $P_1$  in the fingerprint whose information is registered with corresponding part surfaces  $A'_2$  on the sensing surface A,

- means (110) for selecting and approving a number of points  $P_2$  with corresponding part surfaces  $A'_2$  on the sensing surface A, which points  $P_2$ , with their immediate surrounding areas  $A''_2$ , correspond, on the basis of certain criteria, to the stored centre point  $P_1$ , including the immediate surrounding area  $A''_1$  of the stored centre point in the corresponding stored part surface  $A'_1$ ,
- means (110) for processing the approved points in a first step in further processing.

10 10. Arrangement according to claim 9, also comprising means (110, 130) for displacing information about the part surfaces  $A'_2$ , for comparison with the part surfaces  $A'_1$ , into a predetermined number of angular positions, the means for comparison (110, 130) carrying out comparison in each of said angular positions, and the means (110) for selecting and approving a number of points, for the first step in the further processing, approving said number of points  $P_2$  of part surfaces  $A'_2$ , if these points satisfy said conditions in one and the same angular position.

11. Arrangement (100) according to claim 9 or 10, also comprising the following means for carrying out said first step in the further processing:

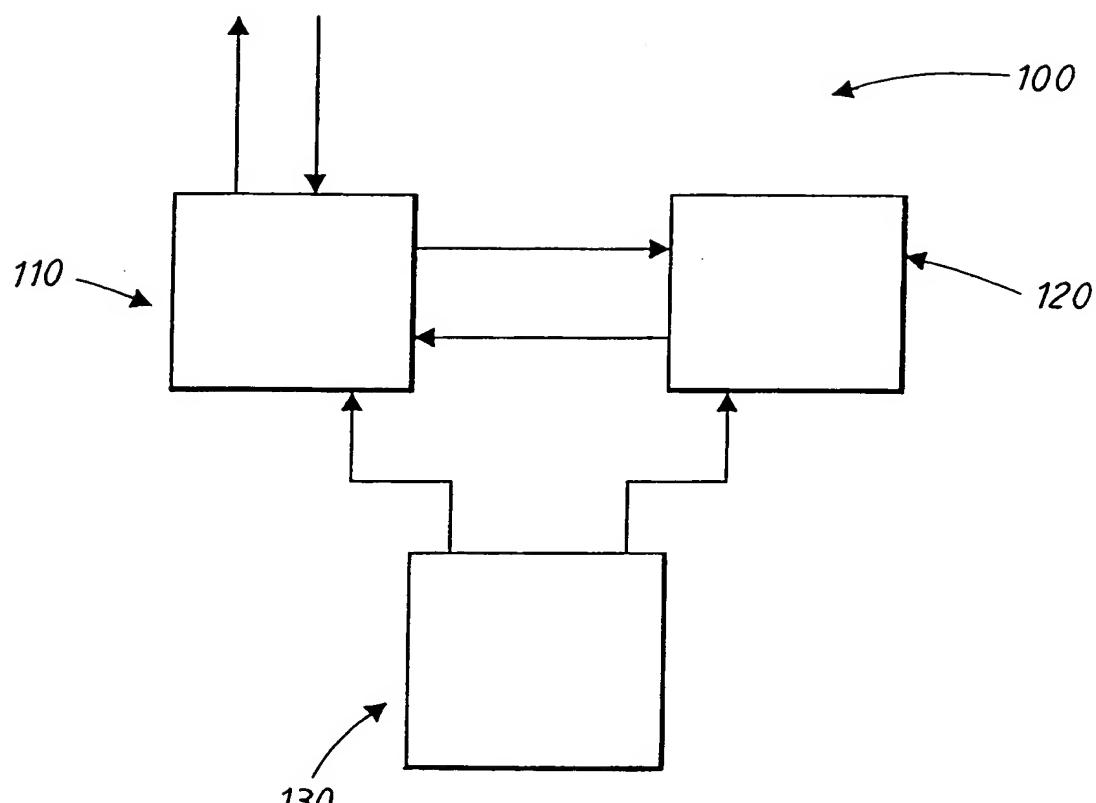
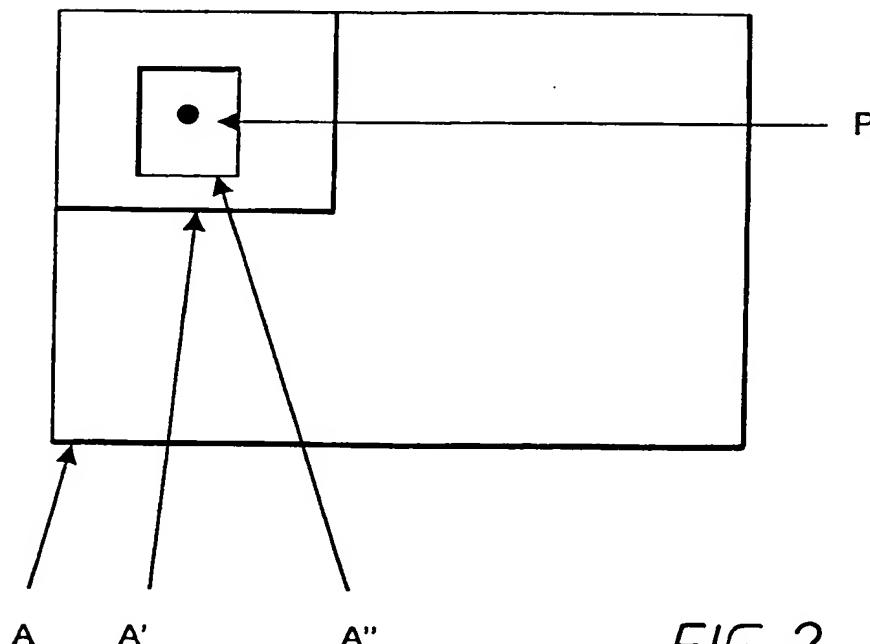
- means (110) for analysing a group of the approved points  $P_2$  and the part surfaces  $A_2$ ,
- means (110) for calculating a mean value point for the coordinates (x,y) of the points  $P_2$  in the part surfaces  $A_2$  in the group,
- means (110) for selecting a certain number of the points  $P_2$  with their associated part surfaces  $A_2$  for a second step in further processing, the points  $P_2$  which are selected being those points which have the smallest distance to the mean value point in their respective part surface  $A_2$ .

30 12. Arrangement (100) according to claim 11, also comprising the following means for carrying out said second step in the further processing:

- means (110) for analysing a group of the points  $P_2$  and the part surfaces  $A_2$  selected for a second step,
- means (110) for calculating a mean value point for the coordinates (x,y) of the points  $P_2$  in the part surfaces  $A_2$  in the group,

- means (110) for calculating the distances between the points  $P_2$  in the group and the mean value point,
- means (110) for analysing whether the distance between a certain number of points  $P_2$  and the mean value point is below a certain limit value, in which case the fingerprint is considered verified.

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FIG. 1FIG. 2

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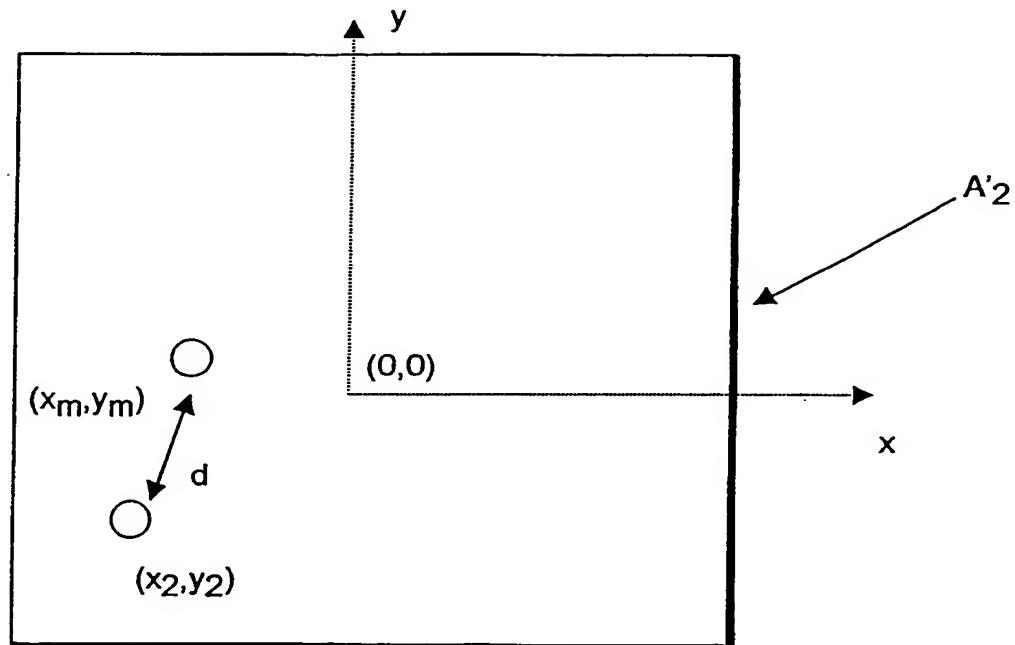


FIG. 3

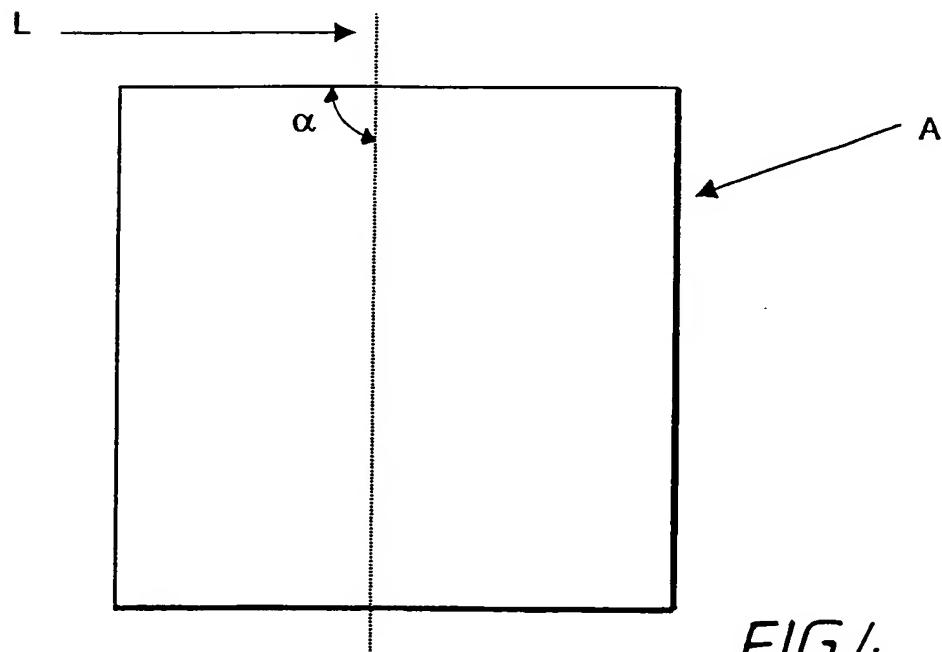


FIG. 4

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/SE 00/01623

## A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G06K 9/50, G06K 9/80, A61B 5/117

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: G06K, A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2310522 A (KABUSHIKI KAISHA MATSUMURA ELECTRONICS), 27 August 1997 (27.08.97), figure 26, abstract --	1-12
A	US 5140642 A (W.H. HSU ET AL.), 18 August 1992 (18.08.92), figure 6, abstract --	1-12
A	US 5239590 A (M. YAMAMOTO), 24 August 1993 (24.08.93), figure 1, abstract --	1-12
A	Precise Biometrics, Linus Wiebe et al: "Automated recognition of fingerprints", see page 33, abstract publ. 1998-04-03 --	1-12

Further documents are listed in the continuation of Box C.  See patent family annex.

* Special categories of cited documents:	
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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

International application No.

PCT/SE 00/01623

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